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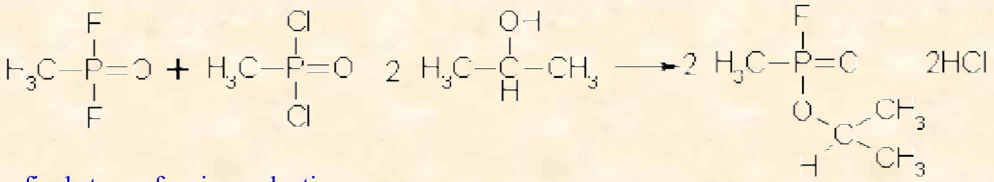
Why Nigel Farage has it all wrong: Smoking guns, Hexamine, and Syrian Sarin

By Dan Kaszeta

This evening witnessed the odd spectacle[i] of Mr. Nigel Farage, MEP and head of the rightwing UK Independence Party, giving ventilation to discredited theories. This is not the first time strange utterances have come from Mr. Farage, but this time he has parked himself squarely in the lane of my expertise. Sadly, he's placed himself on the side of the brutal Assad dictatorship by repeating conspiracy theories that somehow Syrian rebels perpetrated the 21 August 2013 attacks on themselves. This canard has been proved to be substantially wrong. Others address it by means of analysis[ii] of the rockets used, but I rely on the technical aspects of the chemical weapon that was used. I am using this particular opportunity to summarize the work myself and many others have done over the last months to get to the bottom of the 8/21 attacks.
The UN Office of the High Commissioner for Human Rights issued a UN report[iii] that confirms what I have known to be the case for some time. There is evidence tying the Sarin chemical warfare agent used at Ghouta last year to the significant chemical warfare stockpile of the Syrian government. I originally formulated my ideas in November of last year, and provisionally called them the 'Hexamine Hypothesis', a theory which now appears to be vindicated. Indeed, I believe that the chemical hexamine is a unique link tying the Ghouta war crimes to the Syrian government. This article explains the what, why, and how of the 'Hexamine Hypothesis'.

Two general categories of Sarin:

To the layman, Sarin is Sarin. But that's simply not true. I have spent a lot of time and effort studying the history of Sarin and the particularly obtuse history of industrial efforts to produce Sarin. <u>There are at least 20 production pathways to Sarin, each of at least 5 steps.</u> I do not exclude the theoretical possibility of additional pathways to Sarin being developed in a laboratory at some point in the future. All of these methods rely on one of two reactions to produce Sarin in the final chemical reaction. For the purposes of this discussion, we can divide Sarin into two basic categories, based on the final chemical reaction.



The final stage of sarin production

DF + Isopropanol reaction. The simplest methods react DF and Isopropanol. Often, online sources, some of which are of dubious provenance, refer exclusively to these methods. Most of the 20 or so Sarin production pathways use this reaction. This reaction combines DF (methylphosphonyl difluoride) with isopropyl alcohol. 1 mol DF + 1 mol Isopropanol react to create 1 mol Sarin + 1 mol HF (hydrogen fluoride). By mass, this works out to 140 g of HF for each 1 kg of Sarin produced. As you probably can understand, this residual HF is highly dangerous and destructive. It is corrosive to most materials and seriously reduces the shelf-life of the Sarin. Indeed, this reaction is really only suitable for binary-type weapons, and even then only if you do something about the residual HF acid. (More on this later.) The Japanese Aum Shin Rikyo cult, which used Sarin in 1994-1995 in terrorist attacks in Japan used one of the methods using this step. If you are making Sarin to keep for a long period of time, production processes that use this reaction are not very useful as it is indeed hard to get rid of this HF. Saddam Hussein's Iraq discovered this, because they used these methods, and the shelf life of their Sarin could be measured in weeks. The US military used this method in the M687 binary Sarin artillery shell, and found that, without some method to counteract the HF, the binary Sarin weapon systems barely survived the six to ten seconds time of flight of an artillery shell.

"High quality Sarin" – Some critics have made points about whether or not the 8/21

> *Sarin was "high quality" or not. It should be noted that this DF + Isopropanol reaction cannot make "pure" or "high grade Sarin" by definition. This process produces a cocktail of Sarin and HF. It produces a mix that is, at best, 50% Sarin by mol or 87% if you go by weight.*

The DC+DF reaction (The "di-di" process.) - The US and the Soviet Union both realized that DF+Isopropyl worked, but created Sarin that was not very useful for long-term storage. Both the US and the Soviet Union wanted to have weapons that could be kept in long-term storage until they were needed, not artillery shells and rockets that had only a few months shelf-life. In this method, equal parts of DC (methylphosphonic dichloride) and DF are reacted with alcohol to produce Sarin and HCl. From an economic and industrial viewpoint, these DC+DF methods are more complicated, because they require effectively two parallel production paths, one for DF and one for DC. The important difference is the residual contaminant in the Sarin. In the di-di process, the residual is hydrogen chloride (HCl) not HF. While being corrosive and dangerous, is not as difficult to deal with the HCl as is the HF in the other methods. More importantly, it is much more possible on an industrial scale to refine this residual HCl out of the Sarin and get a high purity product. Getting rid of this excess HCl is still not easy and both the US and the Soviet Union had to do a lot of research and spend much time and money to figure out how to do it. These issues were eventually solved, but the effort to do so was measured in years and millions of dollars. It was a complex industrial process and is still considered a secret. Indeed, the US had to re-refine its earlier stockpiles of Sarin in order to ensure a long shelf-life for its Sarin.

Environmental and biomedical samples after 8/21:

The joint UN/OPCW mission collected a number of biomedical and environmental samples. If we delve into the details of both the interim and the final reports as well as various reports and statement made by the OPCW, there are interesting conclusions we can make if we carefully examine the fine details. These are as follows:

- Sarin was used, not some other chemical. We know this for the following reasons:
  - Sarin was actually detected in field samples
  - Both unique and generic Sarin decomposition products were detected in field samples
  - Sarin was re-generated out of protein adducts in human blood using a sophisticated method known as fluoride regeneration.
- The Sarin was binary, produced from a DF + alcohol method. We know this for several reasons:
  - The OPCW's own documents[iv] refer to the Syrian government having binary methods for production of chemical warfare agents. A chemical known as MPFA (methylphosphonofluoridic acid) was found in many of the environmental samples. This is a hydrolysis product of DF. DF degrades quickly into MPFA in the environment. This is no smoking gun on its own, as MPFA is also a decomposition product of Sarin under alkaline conditions.
  - No DF was found. But I would not expect this, as DF is far more volatile than Sarin, and would have either evaporated or degraded.
  - A DC+DF method requires DC. There is no evidence of DC production, DC precursors, or DC decomposition products.
- The chemical hexamine, also known as hexamethylenetetramine, was present in large numbers of the field samples. It would appear that the munitions contained hexamine for some reason. The significance of this finding was unknown to me at the time. But with only one exception (a headscarf), hexamine was in every sample that had Sarin or Sarin decomposition products. There were also many samples that had hexamine, but no Sarin, but this is a logical state of affairs as hexamine does not evaporate like Sarin does.

The Syrian Regime's Declared Inventory of Chemicals

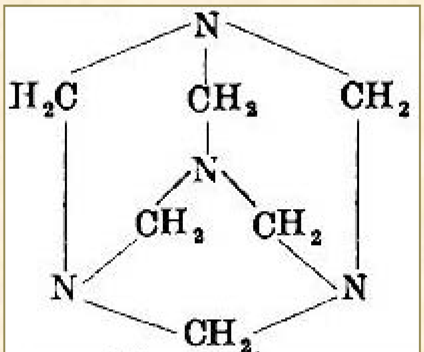
An interesting revelation occurred 20 November 2013. The OPCW issued a document called a "Request for Expression of Interest[v]" for the disposal of chemicals from Syria. This document described the OPCW's requirements to safely get rid of various chemicals from the Syrian government's chemical weapons program. The serious high-grade chemicals, such as chemical warfare agents themselves and immediate precursors aren't listed. So this document represents an effort to get rid of the various feedstock, additive, and waste chemicals that represent less of a proliferation hazard. For example, the list contains 30 tons of phosphorous trichloride, which is an early feedstock chemical in many of the production methods for making Sarin. The list also included 80 tons of hexamine. This is really interesting. There's hexamine all over the battlefield and hexamine in the storage vaults of the Syrian government.

Knowing how the Chemical Weapons Convention is written and understanding how the OPCW works, one can make several assumptions from this revelation.

- ***Assad's government admitted to having 80 tons of hexamine***. This kind of list would only be made based on declarations by the Syrian government. The OPCW inspectors did not have the resources or wherewithal to crawl into every nook and cranny of Syria during an active war. If 80 tons of hexamine are on this list, it is likely because this list was given to the OPCW by the Syrian government.
- ***The Hexamine is for chemical weapons purposes***: The OPCW operates within the terms of its mandate. Hexamine isn't a substance on the various schedules of the CWC. The OPCW has no remit to deal hexamine for its numerous commercial and industrial uses, including the manufacture of RDX, an explosive. If it is on this list, it is because either the OPCW believes it has a use in chemical weapons industrial processes, the Syrians said that it was for such processes, or both.
- ***80 tons ain't cheap to get rid of:*** The OPCW is not going to spend money getting rid of 80 tons of a chemical unrelated to either its remit or the problem at hand.
- ***Hexamine would have been easy to deny***: If the Assad regime wanted to deny the 8/21 attacks, they would have had ample opportunity to do so by not declaring the hexamine. As it is not a scheduled chemical under the CWC it would have been quite easy for Syria to not declare it.

The Hexamine Hypothesis

So, what is the hexamine doing on the list? And why is it all over the battlefield. There are many commercial and industrial uses of hexamine[vi], as a cooking and heating fuel, as the most common example. It also has uses as an anti-corrosion aide. However, it has very little history of use in the history of chemical warfare. Indeed, I researched the subject at some length and the only use I could find was its sporadic use as an anticorrosion additive in the seriously outdated Levinstein Mustard, an older form of Sulfur Mustard (commonly misnamed "Mustard Gas"). **There's no use for hexamine in Mustard production processes after the 1920s,** and it does not occur as trace content in published specifications for either older or more recent US Mustard, nor does it have any use as a precursor.


Hexamine

Hexamine's anti-corrosion properties stem partly or even largely from its ability to bind with acid molecules. This is where it gets interesting. The US Army spent a lot of time trying to turn binary Sarin, made by the DF + Isopropanol method into a useful weapon system. This process, described in detail above, results not in pure Sarin but in a cocktail of Sarin and Hydrogen Fluoride (HF). When the US tried to make weapons, like the M687 155mm howitzer round, using the binary method, this surplus HF was like a wrecking ball inside the munition. Most of the information from the M687 program is still not available, but it takes little imagination or technical knowledge to realize that HF, one of the most corrosive chemicals in existence, will have a serious deleterious effect on things like the case of the shell, the fuze, and the conventional explosive bursting charge. The US military found that the chemical isopropylamine (also noted in the Syrian inventory, by the way) was an isopropanolamine as an additive[vii] to reduce the HF content in Sarin produced by the DF + Isopropanol method. The US M687 howitzer shell combined a cartridge of DF with a cartridge containing a mix of 72% isopropyl alcohol and 28% isopropylamine, a ratio published in the US Army's Field Manual 3-9.

While isopropylamine is the amine compound of record for use in Sarin, other amines are of use for acid scavenging, including hexamine. I found a dissertation on the usefulness of hexamine specifically as an HF scavenger[viii], noting the ability of one molecule of hexamine to bind up to four molecules of HF. I consulted 5 chemists and an engineer, all of whom affirmed to me that hexamine's utility of an acid scavenger. Hexamine can be used in binary Sarin as an acid scavenger, either on its own or in conjunction with isopropylamine. Because this is an "off-label" use of hexamine, and one never done before, if hexamine was in the Syrian government recipe (as implied by the inventory) AND in the field samples, it is strong evidence that the 8/21 Sarin came from government inventories and was made using a unique Syrian government process.

Of particular interest is environmental sample 25, which was taken from the screwthread of a bolt on one of the rockets. No amount of hexamine in the ambient environment for cooking purposes could explain the presence of hexamine on this component of the actual weapon system. There's no physical or mechanical mechanism to explain why hexamine elsewhere in the environment would get onto a screw-thread. Hexamine on the screw thread is consistent with hexamine dissolved in the expected cocktail of substances that result from a binary reaction.

The Hypothesis Confirmed

After working hard to confirm my suspicions about hexamine as the acid reducer in Sarin, I originally broached this idea in an article in NOW Lebanon[ix] in early December 2013. Somini Sengupta at the New York Times interviewed me at length, and an appropriate question was put to the OPCW in congressional hearings on 13 December 2013[x]. Ms. Sengupta put forward the hexamine hypothesis in the New York Times[xi] on 18 December 2013. I knew I was onto something serious because of the furious onslaught of trolling, threats, and general cyberbullying I received as a result of voicing the hexamine hypothesis. Ake Sellstrom, Swedish CBRNE expert and head of the UN/OPCW inspection mission, acknowledged the role of hexamine in the following extract from Sellstrom interview[xii] from his interview with CBRNe World magazine:

> ***CBRNe World*** *- Why was hexamine on the list of chemical scheduled to be destroyed - it has many other battlefield uses as well as Sarin? Did you request to put it on the list or had the Syrian's claimed that they were using it?*
> ***Sellstrom -*** *It is in their formula, it is their acid scavenger.*

I confirmed the veracity of this statement in an email exchange with Prof. Sellstrom, although he did not provide further elaboration. This is as close as I can ever hope to a confirmation of my hexamine hypothesis, and I believe that this was one of the reasons, if not the strongest reason, that the UN firmly concluded that the 8/21 Sarin came from Syrian government stockpiles.

The lack of compelling alternative narratives helps to reinforce the conclusion. Other attempts to come up with a logical explanation for hexamine are based on some combination of wishful thinking, stretches in credibility, and/or faulty chemistry.

Conclusion

I believe the regime committed the 8/21 Sarin attack. The following formula is a useful summation of the evidence:

Nobody's used hexamine previously as a Sarin additive

+

There's hexamine in the field samples

+

There's 80 tons of hexamine in the declared inventory of the Assad Regime

+

The Syrian government's admission to Sellstrom's team

EQUALS

The Assad Regime Did the Wicked Deed

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